SANDIA NATIONAL LABORATORIES
Albuquerque, New Mexico 87185

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TITLE: **INSTRUMENTATION SYSTEM VERIFICATION DURING GAGE CONNECTION TO HP 3497A STAND ALONE DATA ACQUISITION SYSTEMS**

Prepared by: _____ Date: 12/28/94

SNL Reviewer: _____ Date: 12/28/94

SNL Approval: _____ Date: 1/6/95

SNL Safety Approval: _____ Date: 1-4-95

MOC Cognizant Department
Manager Concurrence: _____ Date: 1-10-95

MOC Manager of
Industrial Safety: _____ Date: 1-11-95

SNL QA Approval: _____ Date: 1-16-95

PURPOSE: This document will detail the system verification and connection process for gages associated with the Hewlett Packard (HP) 3497A Data Acquisition System (DAS).

RESPONSIBILITY: It is the responsibility of the person(s) performing this procedure to be familiar with this procedure and references. They are also responsible for assuring that fixtures and measurement devices used are certified or in calibration and working properly.

SAFETY: All work will be done in accordance with the WIPP Safety Manual and any applicable Safe Operating Procedures (SOP's) or Job Hazard Analyses. Other safety requirements may be specified in a Safe Work Permit.

   I. If work is to occur in the underground, access to the underground will be in accordance with existing WIPP Site policies.

  II. If work is to occur in the underground, ground control in the work area will be performed prior to the start of work.

 III. Work will be required with energized circuits (< 20 VDC), proper care shall be exercised at all times.

  IV. While working at a surface well site, personnel will be required to have steel toed boots, safety glasses and hardhats if they are working outside of the DAS trailer.

REFERENCES: (latest revision)

- The applicable Job Hazard Analyses
- The applicable Field Operations Plan
- Gage List for applicable test/experiment
- Cable Spreadsheets for applicable test/experiment
- Measurand Definition File (MDF) for applicable test/experiment
- HP3497A, HP3456A, & EDC501J Operating Manuals
- Copies of the gage calibration records and coefficient sheets

FORMS: (latest revision)

I. SNL Form SSSPT45, "Gage Verification Data Sheet"

II. SNL Form 34, "General Purpose Data Sheet"

III. SNL Form 209, "Field Training Log"

QA RECORDS:

I. SNL Form SSSPT45, "Gage Verification Data Sheet"

II. SNL Form 34, "General Purpose Data Sheet"

III. SNL Form 209, "Field Training Log"

PROCEDURE:

INTRODUCTION: Sections I. and II. of this procedure guide the user through the HP3497A DAS setup configuration and operation of the checkout program. After reviewing these references, proceed to Section III. to initiate cable checkout. Section III. can be performed anytime prior to gage hookup or in conjunction with gage hookup. All training shall be documented on SNL WIPP Form 209, 'Field Training Log'.

I. HP3497A DAS SETUP

NOTE: During performance of this procedure, computer keys and text that are required to be selected or typed by the user will be displayed in capital letters and underlined. Significant screen displays that are provided by the program to prompt the user, will be distinguished from procedure text by being listed in **bold** on a separate line.

A. Insure the DAS is configured properly by performing the following steps, if the DAS is already operational, proceed to step B.

CAUTION: These steps must be performed in sequence to ensure a proper link between the HP3497A. HP3456A, EDC501J and the PC.

1. Verify that the personal computer's (PC) GPIB card (IEEE488) is connected to the HP3497A, HP3456A, and EDC501J using the IEEE488 interface connectors. Turn on the PC and allow it sufficient time to "boot up". The screen will display this message:

   C:\>

2. Turn on the HP3497A, HP3456A, EDC501J and allow the equipment 15 minutes to warm-up before continuing with Section II. of this procedure.

3. Verify that the output of the COM terminals on the HP3497A is connected to the rear input volts terminals on the HP3456A. Insure that proper polarity is maintained.

4. Verify that the front panel switch on the HP3456A is set to read the rear input terminals.

5. Insure the EDC501J output is set to 0.0 VDC and that the front panel switch is in the 'Program' position.

B. Establish communications between the DAS operator and the technician assisting with the "CABLE CHECKOUT" and "INSTRUMENTATION CHECKOUT".

C. Prior to starting the cable checkout and instrumentation checkout the following information must be available for the planned test activity:

   (1) Gage List for applicable test/experiment;

   (2) Cable Spreadsheets for applicable test/experiment; and

   (3) Copies of the gage calibration records and coefficient sheets.

II. OPERATION OF THE "CHECKOUT" PROGRAM

A. Loading the Checkout Program - The checkout program can be run as a stand alone program or from within the "PERM" program. If this is the initial cable checkout for a new test/experiment, the preferred process is to use the stand alone cable checkout program starting with step 2. If the "PERM" program is already running and the activity is the replacement of an existing gage or the adding of additional gages, the preferred method would be to perform step 1. Only step 1. or 2. has to be performed, not both of them.

1. This step refers to performing the cable checkout with the "PERM" program already operating on the DAS-PC. It is recommended this step be used when the DAS is already operating and the test requires the additional connection of a gage or a gage requires replacement.

   a. To perform a gage/cable checkout with the DAS up and running on a test, press the F10 function key on the PC keyboard to load "GAGE CHECKOUT". The screen will display the following message and prompt:

      *****FUNCTION KEY=F10*****

      THIS OPTION WILL ALLOW YOU TO SELECT, MEASURE, AND DISPLAY A CHANNEL'S VOLTAGE OR RESISTANCE VALUE.

      Do you want to do this? (Y/N) [N]?

      NOTE: Pressing the ENTER key will cause the default (shown in brackets) to be selected.

   b. Answer Y or N. If N was entered, the "GAGE CHECKOUT" procedure will be exited, and the screen will return to the display of the measured data. If Y was entered, the screen will display:

      PROGRAM CHECKOUT START: MM/DD/YYYY HH:MM:SS

      ENTER CHANNEL NUMBER ('E' TO EXIT)

   c. To determine the channel number of a particular gage, refer to the Cable Spreadsheet wiring diagram, or the Measurand Definition File (MDF).

   d. If channel 10 is the desired channel, type 10 and press ENTER. The screen will display this additional message:

      CHANNEL = 10
      VOLTS or OHMS? (V/O) [V]

      NOTE: The message displayed in the previous step indicates that Volts [V] is the default selection. If [O] is displayed instead of [V], then Ohms is the default selection.

   e. If the default selection is desired press ENTER. If the default measurement type is not desired, then type O for Ohms or V for Volts and press ENTER.

f. The program will access the selected parameter and will display it in loop scan format. As an example if channel 10 was connected to a ~3 Volt signal source and was being scanned, the screen would display:

CHANNEL = 10   VOLTS = 3.124199
CHANNEL = 10   VOLTS = 3.NNNNNN
CHANNEL = 10   VOLTS = 3.NNNNNN
CHANNEL = 10   VOLTS = 3.NNNNNN
CHANNEL = 10   VOLTS = 3.NNNNNN
CHANNEL = 10   VOLTS = 3.NNNNNN
CHANNEL = 10   VOLTS = 3.NNNNNN
CHANNEL = 10   VOLTS = 3.NNNNNN
CHANNEL = 10   VOLTS = 3.NNNNNN
CHANNEL = 10   VOLTS = 3.NNNNNN

1 | STOP | 2   3   4   5   6   7   8   9   10

g. Press F1 to stop the loop scan. The screen will display lines of loop scan data and:

ENTER CHANNEL NUMBER ('E' TO EXIT)

h. If another channel is desired, return to step 1.c. If loop scans are complete type E and press ENTER. The screen will display the last screen of loop scan data, with the last line being the exit message, date and time:

PROGRAM CHECKOUT EXITED: MM/DD/YYYY HH:MM:SS

PAUSE: PRESS <ENTER> TO CONTINUE

i. Proceed to Section III.

2. This step refers to performing the cable checkout when the "PERM" is not operating on the DAS-PC. It is recommended this step be used to perform cable checkout prior to the start of the test/experimental activity.

a. To start the gage checkout program type CHECKOUT and press ENTER. The screen will display the following message and prompt:

*****PROGRAM "CHECKOUT"******

THIS PROGRAM WILL ALLOW YOU TO SELECT, MEASURE, AND DISPLAY A CHANNEL'S VOLTAGE OR RESISTANCE VALUE.

Do you want to do this?   (Y/N) [N]?

NOTE: Pressing the ENTER key will cause the default (shown in brackets) to be selected.

b. Answer Y or N. If N was entered, the "GAGE CHECKOUT" program will be exited, and the screen will return to the **C:>** prompt. If Y was entered, the screen will display:

BEFORE CONTINUING, VERIFY THAT THE INSTRUMENTATION HP3456A DMM AND HP3497A IS ON AND WARMED UP.

WHEN READY TO CONTINUE, PRESS ANY KEY.

c. After any key has been pressed, the computer will display screens and steps for verifying and setting the HP3456A DMM and the HP3497A addresses.

(1) To verify the equipment addresses press their respective reset buttons and view the front panel meter for their address number.

(2) If the equipment addresses match the default addresses as stated in the program respond accordingly.

(3) If the addresses do not match the default values displayed on the screen, respond accordingly and enter the actual equipment addresses. (if needed, refer to SNL Procedure 509, Section II.D. for help).

Optional: The equipment addresses can be changed to match the default values of the "CHECKOUT" program. Consult the operational manuals for the equipment in order to change the equipment addresses.

d. After completing the equipment address verification, the screen will display:

PROGRAM CHECKOUT START: MM-DD-YYYY HH:MM:SS

ENTER CHANNEL NUMBER ('E' TO EXIT)

e. To determine the channel number of a particular gage, refer to the Cable Spreadsheet wiring diagram, or the Measurand Definition File (MDF).

f. If channel 10 is the desired channel, type 10 and press ENTER to select it. The screen will display this additional message:

CHANNEL = XXX
VOLTS or OHMS? (V/O)   [V]

NOTE: The message displayed in the previous step indicates that Volts [V] is the default selection. If [O] is displayed instead of [V], then Ohms is the default selection.

g. If the default selection is desired press ENTER. If the default measurement type is not desired, then type Q for Ohms or V for Volts and press ENTER.

h. The program will access the selected parameter and will display it in loop scan format. As an example if channel 10 was connected to a ~3 Volt signal source and was being scanned, the screen would display:

CHANNEL = 10   VOLTS = 3.124199
CHANNEL = 10   VOLTS = 3.NNNNNN
CHANNEL = 10   VOLTS = 3.NNNNNN
CHANNEL = 10   VOLTS = 3.NNNNNN
CHANNEL = 10   VOLTS = 3.NNNNNN
CHANNEL = 10   VOLTS = 3.NNNNNN
CHANNEL = 10   VOLTS = 3.NNNNNN
CHANNEL = 10   VOLTS = 3.NNNNNN
CHANNEL = 10   VOLTS = 3.NNNNNN
CHANNEL = 10   VOLTS = 3.NNNNNN

1 | STOP | 2   3   4   5   6   7   8   9   10

i. Press F1 to stop the loop scan. The screen will display lines of loop scan data and:

ENTER CHANNEL NUMBER ('E' TO EXIT)

j. If another channel is desired, repeat steps 2.e. - i. If loop scans are complete type E and press ENTER. The screen will display the last screen of loop scan data, with the last line being the exit message, date and time:

PROGRAM CHECKOUT EXITED: MM-DD-YYYY HH:MM:SS

C:>

III. CABLE CHECKOUT

A. Preparation - Only perform sections of Cable Checkout which apply to the test/experiment being performed.

1. Prepare SNL Form 34 for use as a Cable Checkout data sheet. Complete the upper three header blocks and label the columns as follows:

Column 1   "Gage No."
Column 2   "Pair No."
Column 3   "Channel No."
Column 4   "Resistance Check"
Column 5   "Polarity Check"
Column 6   "Resistor ID No."

2. Refer to Cable spreadsheet and identify the cable that interfaces to the gages requiring hookup. Use this information to complete the "Use:" blank on SNL Form 34.

Example: Use: Cable L3/EXT Checkout

3. Refer to Cable spreadsheet to identify the corresponding channel numbers for all gage/cable pairs in this cable.

NOTE: HP3497A internal reference thermocouples and EDC501J voltage standards will be excluded from the "Cable Checkout" process.

4. On SNL Form 34 record all of the Gage Numbers (including power supplies), the Pair Numbers, and the Channel Numbers for this cable in the designated columns.

NOTE: Hardwired power supplies will not be disconnected or removed.

5. De-energize and disconnect or remove the power supplies assigned to the gages supplied by this cable.

6. If the cable to be tested is terminated with a connector, attach a cable checkout box or short jumpers to end of cable.

B. Cable Resistance Checks

1. Select the desired channel number.

2. Place the gage/cable pair channel into an Ohms loop scan.

3. Request the field technician to place a short on the end of the corresponding cable pair.

4. Record the measured resistance on SNL Form 34 in the "Resistance Check" column. If the reading indicates an open or "dead" short, contact the SNL Cognizant Engineer.

5. Remove the short from the cable pair, observe open condition, and stop the loop scan.

6. Repeat steps 1. through 5. for all the gage/cable pairs on the selected cable and for all cables being used in the test/experimental activity.

C. Cable Polarity Check

1. Thermocouple Cable

   a. Select the desired channel number.

b. Place the gage/cable pair channel into a Volts loop scan.

   NOTE: For hardwired systems the installed thermocouple maybe used as a simulator.

c. Connect a Thermocouple Simulator or 9 VDC battery to the selected cable pair. Be sure to maintain the correct polarity.

d. Monitor the voltage output while applying heat to the Simulator junction.

e. If the voltage increases during the application of heat, note OK in the "Polarity Check" column of SNL Form 34.

f. Remove the heat from the Simulator or remove the 9 VDC battery and observe the drop in voltage.

g. If the conditions stated in steps e. and f. are not observed, contact the SNL Cognizant Engineer.

h. Stop the loop scan.

i. Repeat steps a. through h. for all the TC/cable pairs on the selected cable.

2. All Other Cable Types

a. Select the desired channel number.

b. Place the gage/cable pair channel into a Volts loop scan.

   NOTE: If testing a cable pair that uses a current viewing resistor(CVR), temporarily disconnect the resistor prior to performing step c. The battery will need to be directly connected to the CVR terminal strip connection points (rather than to a cable checkout box or other interface point).

c. Connect a 9 VDC battery to the selected cable pair. Ensure that the + battery pole is connected to the positive cable lead and the - battery pole to the negative cable lead.

d. Record the measured voltage on SNL Form 34 in the "Polarity Check" column. If the reading is negative contact the SNL Cognizant Engineer.

e. Disconnect the battery.

f. Stop the loop scan.

g. Repeat steps a. through f. for all the gage/cable pairs on the selected cable.

D. Power Supply Checkout

1. Reconnect or reinstall the power supplies disconnected in step A. 5.

2. Ensure that the first power supply to be tested is de-energized.

3. If the gage jumper is not in the circuit, (and if applicable) jumper the gage excitation leads (power supply) to the gage monitor leads. Ensure that correct polarity is maintained.

4. Select the first of the corresponding channel numbers for this power supply.

5. Place the gage/cable monitor pair channel into a Volts loop scan.

6. Energize the power supply and observe the increase in voltage while slowly adjusting it to the desired excitation voltage.

7. Record the measured voltage on SNL Form 34 in the "Polarity Check" column.

8. If the readings varies by more than $\pm$ .01 VDC while being monitored, contact the SNL Cognizant Engineer.

9. De-energize the power supply.

10. Stop the loop scan.

11. Repeat steps 2. through 15. for all the power supplies on the selected cable.

E. Completion

1. If the cable that was tested is terminated with a connector, disconnect the cable checkout box from the end of the cable.

2. If there are additional cables to checkout, return to Section III.A.

3. If complete, exit the Checkout program.

4. If gage hookup to the DAS is desired continue with the next section, otherwise proceed to Section VII. The system will have returned to the **C:>** prompt if the cable checkout occurred using the "Checkout" program.   If cable checkout occurred from within the "PERM" program the general data scanning window will return.

IV. CABLE AND GAGE RESISTANCE MEASUREMENTS

A. Cable Checkout

NOTE: Hardwired power supplies will not be disconnected or removed.

1. Complete the header sections of SNL form SSSPT45. During performance of this procedure note any discrepancies in the comments section.

2. Review the Cable Spreadsheet and Gage List references and identify the corresponding information for the gage(s) to be checked out (including reference voltages, reference thermocouples, power supply assignments, and current viewing resistor assignments). Record these parameters on SNL Form SSSPT45 in "Gage No.", "Gage S/N", and "Channel No." columns.

3. De-energize and disconnect or remove the power supply assigned as the excitation source for the gage(s) to be tested.

4. Verify the configuration of Current Viewing Resistors (CVRs) relative to terminal strip and gage serial number assignments (Cable Spreadsheet and Gage List). Install or replace CVRs and jumpers (shorts) at their terminal strip locations, as required to complete the requested configuration.

5. Select the desired channel and place the gage output pair into an Ohms loop scan.

6. If the cable can be separated from the gage at the gage, perform steps 7. through 10. If the gage and cable are sealed, continue on with step B.

7. Request the field technician to place a short on the gage signal end of the corresponding cable pair.

    NOTE: Step 7. may be deleted for internally wired gages (reference TCs, etc.) which are inaccessible.

    a. Gage termination via connector.

(1) Temporarily disconnect the cable connector(s) from the gage(s).

(2) Apply a short across the corresponding cable connector pins.

b. Gage termination via junction box.

(1) Access the terminal strip inside the junction box.

(2) Apply a short across the corresponding terminal strip connections.

8. Record the displayed resistance measurement on SNL Form SSSPT45 in the "Cable Resistance" column.

9. Remove the short from the cable pair, observe and confirm the open circuit, and stop the loop scan.

10. Repeat steps 5. through 10. for the gage monitor pair.

11. Repeat steps 5. through 11. for all gages being installed.

B. Gage Checkout

1. If the gage(s) was disconnected in Section IV.A.6.a., reconnect the gage(s) to the cable connector(s).

2. Place the gage output pair into an Ohms loop scan.

a. If the gage is a 4-20ma gage, before checking resistance remove (open) one side of the 'CVR' from the terminal block. Also place a short across the power supply terminals in the DAS interface box.

b. After recording the gage and cable resistance, remove the short from the power supply and reinstall the 'CVR'.

c. If the gage is a voltage output type gage , the cable and gage resistance can be read directly without changing the cable configuration.

3. Record the displayed resistance measurement on SNL Form SSSPT45 in the "Cable + Gage Resistance" column.

4. Stop the loop scan.

5. Repeat steps 2. through 4. for the gage excitation monitor.

6. Repeat steps 1. through 5. for all gages being installed.

V. GAGE AND POWER SUPPLY MONITOR VOLTAGE MEASUREMENTS

A. EDC501J Voltage Standard Checkout

1. Switch the front panel switch to 'Manual".

2. Set the 501J output switches to 10.0 VDC.

3. Record the displayed voltage measurement on SNL Form SSSPT45 in the "Output Volts" column.

4. Return 501J output switches to 0.0 VDC and front panel switch to 'Program'.

B. Power Supply Checkout

1. If applicable, reconnect or reinstall the power supply disconnected in Section IV.A.4.

2. Place the gage excitation monitor channel into a Volts loop scan.

3. Energize the power supply.

4. While viewing the power supply monitor voltage on screen, adjust the power supply output to the gage calibration excitation voltage (+/- 0.01 VDC).

5. Record the displayed voltage measurement on SNL Form SSSPT45 in the "Output Volts" column.

6. Stop the loop scan.

C. Gage Checkout

1. Place the gage output channel into a Volts loop scan.

2. Record the displayed voltage measurement on SNL Form SSSPT45 in the "Output Volts" column.

3. Stop the loop scan.

4. De-energize the power supply and disconnect the cable connector from the gage.

D. If there are additional gages to checkout, repeat Sections IV. and V.

E. If gage checkouts are complete, reconnect all gages, energize the power supply, and adjust to the gage calibration excitation voltage (+/- 0.01 VDC).

F. Exit the checkout program.

VI. System Checkout of Instrumentation (optional) - Only perform those sections of Instrument Checkout which apply to the gages being used in the applicable test/experiment. Many of the checkout steps can be accomplished by a compliance test at field location.

A. With the PERM program running and the DAS system scanning the gages. Perform the following steps.

1. Prepare SNL Form 34 for use as a Cable Checkout data sheet. Complete the upper three header blocks and label the columns as follows: (Be sure to record certification information on any standards used in the checkout process.)

   Column 1   "Gage No."
   Column 2   "Initial Static Reading"
   Column 3   "Dynamic Reading"
   Column 4   "Final Static Reading"
   Column 5   "Test Standard Reading"

2. Pressure Gage Checkout

   a. With the pressure transducers in a static condition (monitoring ambient pressure), record in the 'Initial Static Reading' column of form 34 the gage outputs.

   b. Using a portable pressure standard to monitor the ambient pressure, record the reading in the 'Test Standards Reading' column of form 34.

   c. Connect the pressure gages to a pressure source.

   d. Slowly increase the pressure to a value determined by the SNL cognizant engineer and verify the increase in the pressure readings on the DAS. The DAS pressure readings should correlate with the pressure value being applied at the instrument.

   e. Record the readings in the 'Dynamic Readings' column of a Form 34. Also record in the 'Test Standards Reading' column the pressure increment being applied to the gages.

   f. Remove the pressure source from the gages and allow them to stabilize at the ambient pressure. Record in the 'Final Static Reading' column of form 34 the output of the pressure transducers.

3. Thermocouple Gage Checkout

   a. With the Thermocouples in a static condition (monitoring ambient temperature), record in the 'Initial Static Reading' column of form 34 the Thermocouple outputs.

b. Using a reference temperature device to monitor the ambient temperature, record the reading in the 'Test Standards Reading' column of form 34.

c. Apply heat to system Thermocouples using a heat gun or equivalent.

d. Record the readings in the 'Dynamic Readings' column of a Form 34. Also record in the 'Test Standards Reading' column the temperature increment being applied to the thermocouples.

e. Remove the heat source from the thermocouples and allow them to cool and stabilize at the ambient temperature. Record in the 'Final Static Reading' column of form 34 the output of the thermocouples.

VII. ACCEPTANCE CRITERIA REVIEW AND COMPLETION OF DATA FORM

A. Cable Checkout

1. Complete SNL Form 34 and route it to the SNL Cognizant engineer.

2. The SNL Cognizant Engineer will technically review the data and comments to ensure that the checkout meets the stated acceptance criteria specified in this procedure.

3. Approval of the data form by the SNL Cognizant Engineer indicates that the cables are adequate for their intended use, based on the Cognizant Engineer's experience/expertise.

4. The original data form will be routed to the SNL Quality Assurance department.

B. Gage Verification

1. Complete SNL Form SSSPT45 and route it to the SNL Cognizant Engineer.

2. The SNL Cognizant Engineer (CE) will technically review the data and comments to ensure that the installation meets the stated acceptance criteria specified in this procedure.

3. Approval of the data form by the SNL CE indicates that the gages are adequate for their intended use, based on the CE's experience/expertise.

4. The CE will forward the data form to the PI or designee for review.

5. Final approval of the data form by the PI or designee indicates that the gages are properly installed into the data acquisition system.

6. The original data form will be routed to the SNL Quality Assurance department.

REVISION SUMMARY

To be completed by procedure's author before final revision is circulated for signatures.

I. Revisions made:_____

_____

_____

_____

II. Personnel effected:

(Check appropriate ones)

MOC Craftsman		SNL JOB AREA	
Drilling	____	DAS General	____
Shop	____	DAS B49 Trailer	____
Mechanical	____	DAS Sheds	____
Electrical	____	DAS Equip. Cal. & Inv.	____
Gage	____	Thermocouple	____
Cable/TC	____	Cables	____
U/G DAS	____	Drilling	____
Geotech	____	Gage Installation	____
		Gage Cal. & Removal	____
		Plugging & Sealing	____
		Brine Transport	____
		QA	____
		General	____
		Principal Investigator	____
		Bin Leak Tester	____
		Permeability Testing	____

III. Retraining required:

(Circle One)

Read/Re-read procedure

Practical demonstration

Other (explain)

_____

_____

Signature of
Procedure's Author_____ Date_____